

DATATAPE®

12-457G
FM REPRODUCE
AMPLIFIER

TECHNICAL MANUAL



DATATAPE DIVISION

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SECTION I

GENERAL DESCRIPTION

1-1. GENERAL.

1-2. This manual describes the Bell & Howell Type 12-457G FM Reproduce Amplifier.

1-3. In frequency modulation recording, the amplitude/time relationship of the data input signal is first converted to a frequency/time relationship and then recorded on magnetic tape. Its wider dynamic range capabilities result from the fact that a record of amplitude excursion is not restricted by the level at which magnetic saturation of the tape occurs. Additional benefits of this principle are improved linearity and relative freedom from dropouts. Low frequency response extending downward to dc is implicit, limited only by capstan stability.

1-4. EQUIPMENT DESCRIPTION.

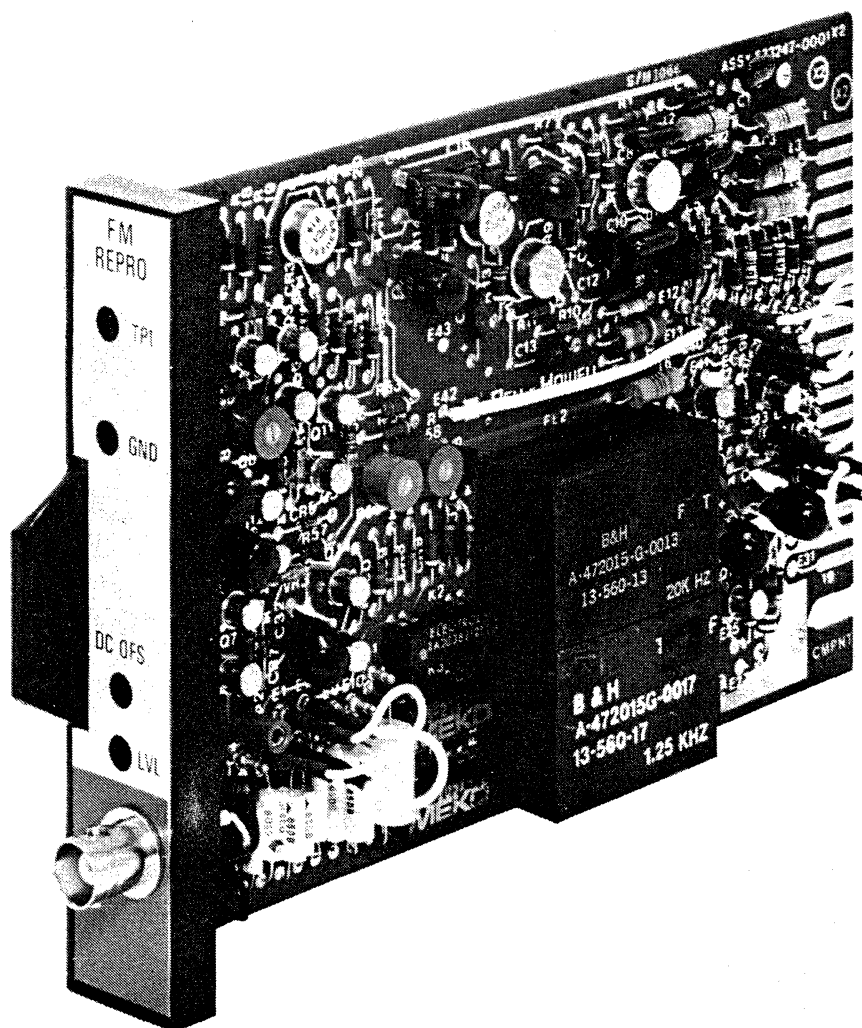
1-5. The 12-457G FM Reproduce Amplifier, illustrated in figure 1-1, is constructed on a printed circuit board similar to the other record and reproduce amplifiers used in this record/reproduce system. One circuit board is used per channel. Each circuit board plugs into a connector in the amplifier case assembly and is positioned by guide slots. Operating power is furnished when the circuit board is installed in the amplifier case assembly. The components are mounted on one side of a double sided printed circuit board. A shield, to minimize RF interference and coupling between amplifiers, is mounted on the back side of the circuit board. The dimensions of the FM reproduce amplifier are 4-19/32 inches high by 7-3/8 inches deep by 29/32 inches wide.

1-6. The input signal is normally through a BNC connector on the front panel. The most commonly used controls and test points are also accessible from the front of the circuit board.

1-7. One circuit board is used for IRIG Extended Wide Band Group I, IRIG Wide Band Group I, and IRIG Intermediate Band. The desired band is selected by placement of the appropriate jumper and filters on the circuit board. Each circuit board is compatible with all speeds of the tape transport, however, only two tape speeds can be selected per card. Due to compact size of the circuit board, only two filters can be accommodated.

1-8. PERFORMANCE CHARACTERISTICS.

1-9. Typical performance characteristics for the Bell & Howell 12-457G FM Reproduce Amplifier are given in table 1-1.



KH3608-8

Figure 1-1. 12-457G FM Reproduce Amplifier

ITEM	CHARACTERISTIC																								
Input Source	Reproduce head preamplifier.																								
Output Level	4 volts peak-to-peak into 600 ohms.																								
Output Impedance	Less than 30 ohms. May be matched into load by insertion of series resistor.																								
Response Characteristics	Switch selectable for flat amplitude or optimum transient response. a. Flat amplitude: Frequency response flat within <u>+0.5</u> dB from dc to cutoff. Less than 14% overshoot for a step function input. b. Transient: Frequency response flat within <u>+0.5</u> dB and -3 dB. Less than 6% overshoot and 1% pre-ring for a step function input.																								
DC Linearity	<u>+0.5%</u> of full deviation from best straight line through zero.																								
Operating Temperature	0° to 50°C.																								
Power	-15 Vdc, 50 mA; +15 Vdc, 100 mA; +5 Vdc, 50 mA.																								
Center Frequency and Bandwidth	IRIG Intermediate Band <u>+40%</u> Deviation <table><tr><th><u>Tape Speed</u> (ips)</th><th><u>Center</u> <u>Frequency</u> (kHz)</th><th><u>Bandwidth</u> (kHz)</th></tr><tr><td>60</td><td>108</td><td>DC to 20</td></tr><tr><td>30</td><td>54</td><td>DC to 10</td></tr><tr><td>15</td><td>27</td><td>DC to 5</td></tr><tr><td>7-1/2</td><td>13.5</td><td>DC to 2.5</td></tr><tr><td>3-3/4</td><td>6.75</td><td>DC to 1.25</td></tr><tr><td>1-7/8</td><td>3.375</td><td>DC to 0.625</td></tr><tr><td>15/16</td><td>1.6875</td><td>DC to 0.3125</td></tr></table>	<u>Tape Speed</u> (ips)	<u>Center</u> <u>Frequency</u> (kHz)	<u>Bandwidth</u> (kHz)	60	108	DC to 20	30	54	DC to 10	15	27	DC to 5	7-1/2	13.5	DC to 2.5	3-3/4	6.75	DC to 1.25	1-7/8	3.375	DC to 0.625	15/16	1.6875	DC to 0.3125
<u>Tape Speed</u> (ips)	<u>Center</u> <u>Frequency</u> (kHz)	<u>Bandwidth</u> (kHz)																							
60	108	DC to 20																							
30	54	DC to 10																							
15	27	DC to 5																							
7-1/2	13.5	DC to 2.5																							
3-3/4	6.75	DC to 1.25																							
1-7/8	3.375	DC to 0.625																							
15/16	1.6875	DC to 0.3125																							

Table 1-1. 12-457G FM Reproduce Amplifier Performance Characteristics (Sheet 1 of 2)

ITEM	CHARACTERISTIC		
IRIG Wide Band Group I <u>+40%</u> Deviation			
	<u>Tape Speed (ips)</u>	<u>Center Frequency (kHz)</u>	<u>Bandwidth (kHz)</u>
	60	216	DC to 40
	30	108	DC to 20
	15	54	DC to 10
	7-1/2	27	DC to 5
	3-3/4	13.5	DC to 2.5
	1-7/8	6.75	DC to 1.25
	15/16	3.375	DC to 0.625
	15/32	1.6875	DC to 0.3125
IRIG Extended Wide Band Group I <u>+40%</u> Deviation			
	<u>Tape Speed (ips)</u>	<u>Center Frequency (kHz)</u>	<u>Bandwidth (kHz)</u>
	60	432	DC to 80
	30	216	DC to 40
	15	108	DC to 20
	7-1/2	54	DC to 10
	3-3/4	27	DC to 5
	1-7/8	13.5	DC to 2.5
	15/16	6.75	DC to 1.25

Table 1-1. 12-457G FM Reproduce Amplifier Performance
Characteristics (Sheet 2 of 2)

SECTION II

INSTALLATION

2-1. GENERAL.

2-2. When the 4020 system is installed on an initial installation, the FM reproduce amplifiers are installed as part of the installation procedure. Refer to Section II of the system manual for the installation procedures.

2-3. When replacing an FM reproduce amplifier, follow the installation procedures in Section II of the system manual. It will also be necessary to perform the calibration procedures described in the Calibration and Maintenance Section (Section V) of the system manual for the FM record/reproduce electronics.

2-4. Tables 5-10, 5-11, and 5-12 in the system manual give the jumper tabulations for the 12-457G FM Reproduce Amplifier. Ensure that each amplifier is properly jumpered in accordance with the tables.

SECTION III

OPERATION

3-1. GENERAL.

3-2. The 12-457G FM Reproduce Amplifier is fully operational when power is turned on. Refer to Section III of the system manual for the operational procedures for the FM reproduce amplifier, as the FM reproduce amplifier must be used in conjunction with an FM record amplifier.

3-3. Ensure that the FM reproduce amplifiers are properly jumpered for the particular operating requirements. Tables 5-10, 5-11, and 5-12 in the system manual give the jumper tabulations for each bandwidth.

SECTION IV

THEORY OF OPERATION

4-1. GENERAL.

4-2. The frequency modulation method of magnetic tape recording causes data to be recorded on tape in the form of variations in frequency about a center frequency. The amount of frequency deviation from the center frequency is determined by the amplitude of the data signal. The rate at which the frequency to be recorded varies about the center frequency is determined by the frequency of the data signal. At the positive excursions of the input data signal, the signal to be recorded will be of a higher frequency than the center frequency. At the negative excursions of the input data signal, the signal to be recorded will be of a lower frequency than the center frequency.

4-3. The function of the 12-457G FM Reproduce Amplifier is to recover the data by demodulating the FM signal recorded on the tape. Figure 4-1 is a block diagram of the 12-457G FM Reproduce Amplifier circuitry. The input circuit may be modified to receive either differential or single ended signals by means of jumpers. The single ended connection makes it compatible with the 12-401A, or earlier, transports. The differential connection makes it compatible with the 12-401B, and later, transports. The input amplifier provides gain and amplitude equalization. Three limiter stages are used to remove any amplitude variations from the reproduced FM signal. A flip-flop, constant-area pulse generator, and low pass filter serve together as a Pulse Averaging Discriminator. An output amplifier following the discriminator provides an adequate output signal level. A schematic diagram of the FM reproduce amplifier is shown in figure 7-1.

4-4. A transport controlled squelch circuit is utilized to prevent any output from the FM reproduce amplifier when the transport is not phase locked in the run mode.

4-5. CIRCUIT DESCRIPTION.

4-6. BIAS TRAP. The bias trap is a frequency selective voltage divider which prevents the 4 MHz bias used in direct recording from entering the FM reproduce amplifier. With differential input data, a parallel resonant circuit is located in each input leg, and a series resonant circuit connects the input legs together. These circuits consist of C1 and L1, C2 and L2, and C3 and L3. Parallel resonant circuits C1 and L1, and C3 and L3 exhibit a high impedance to the bias frequency. C2 and L2 present a low impedance to the bias frequency.

4-7. INPUT AMPLIFIER. The input amplifier, U1, is an operational amplifier with an inverting and a noninverting input, pins 2 and 3, respectively. The data signal, after passing through the bias trap, is coupled through C4 and C5 to the input of U1. Negative feedback is provided from the output of U1, pin 6, through resistors R6 and R5 to the inverting input of U1, pin 2. The gain determining network includes R1, R2, R3, R4, R5, R6, R22, R23, R24, R25, R26, R27, R28, R29, R30, C8, L4, Q1, and Q2.

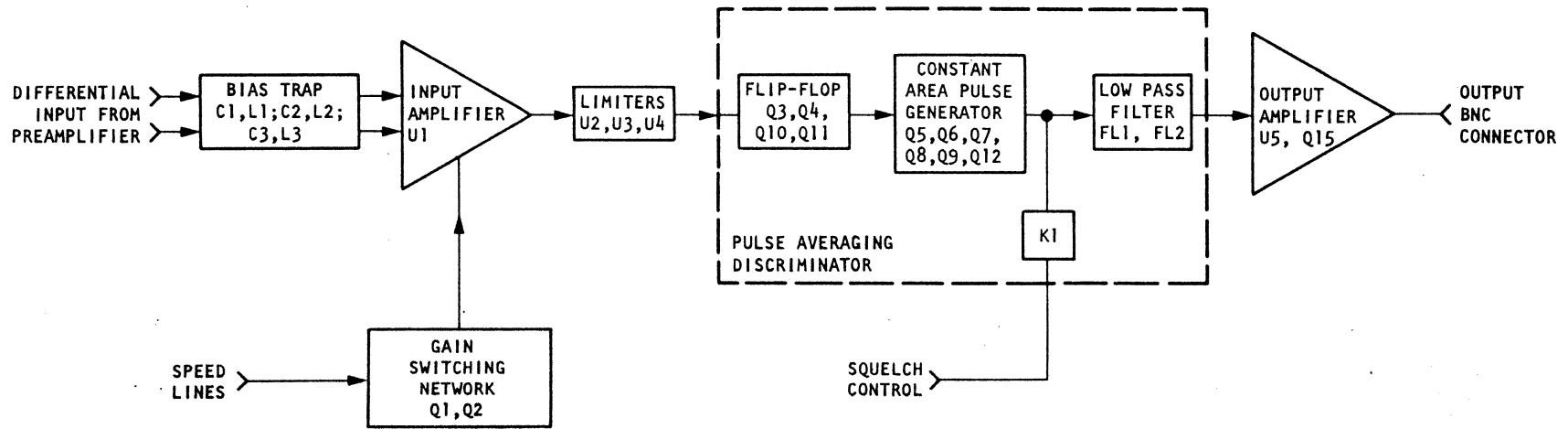


Figure 4-1. Block Diagram, 12-457G FM Reproduce Amplifier

4-8. When a tape speed is selected, speed switching transistors Q1 and Q2 must be jumpered to the appropriate shunt resistors R22, R23, R24, R25, R26, R27, R28, R29, or R30. Transistor Q1 or Q2 is switched on by the selected speed control line, +15 Vdc, providing a shunt resistance across R2. Progressively lower values of shunt resistance are applied as lower tape speeds are selected. This ensures that the output level of the amplifier will remain adequate at each speed.

4-9. LIMITER AMPLIFIERS. Three integrated circuit differential amplifiers, U2 through U4, are connected in cascade to provide limiting. Refer to figure 4-2 for a schematic diagram of the limiter amplifier. The signal from the input amplifier, U1, is coupled by C12 and R8 to input pin 1 of the first limiter, U2. The output of U2 is single ended from pin 6 and coupled through C15 to pin 1 of the second limiter, U3. The output of U3 is also single ended and coupled to the following stage through C16. The three limiter stages are placed in cascade to ensure that the differential output of U4 will be hard limited square waves for all normal variations in reproduced signal level.

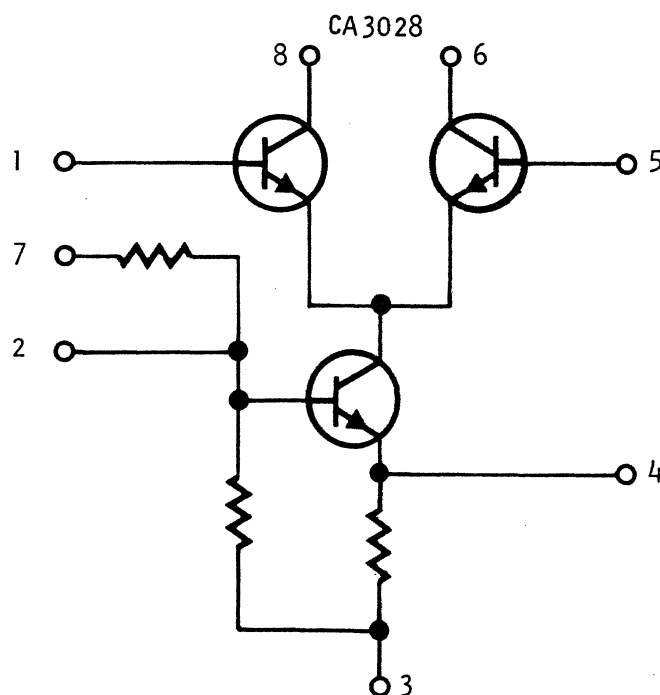


Figure 4-2. Limiter Amplifier Schematic

4-10. PULSE AVERAGING DISCRIMINATOR. The discriminator is composed of three separate circuits, a flip-flop, a constant-area pulse generator, and a low-pass filter network. Each of these circuits is discussed in the following paragraphs.

4-11. Flip-Flop. The flip-flop consists of transistors Q3, Q4, Q10, Q11 and associated components. It is the first stage of the discriminator circuitry, serving as an interface between the differential output of the final limiter stage, U4, and the constant-area pulse generator. It causes the pulse generator to produce constant-area pulses at double the rate of the reproduced frequency modulated signal. Refer to figure 4-3 for a schematic diagram of the flip-flop circuit.

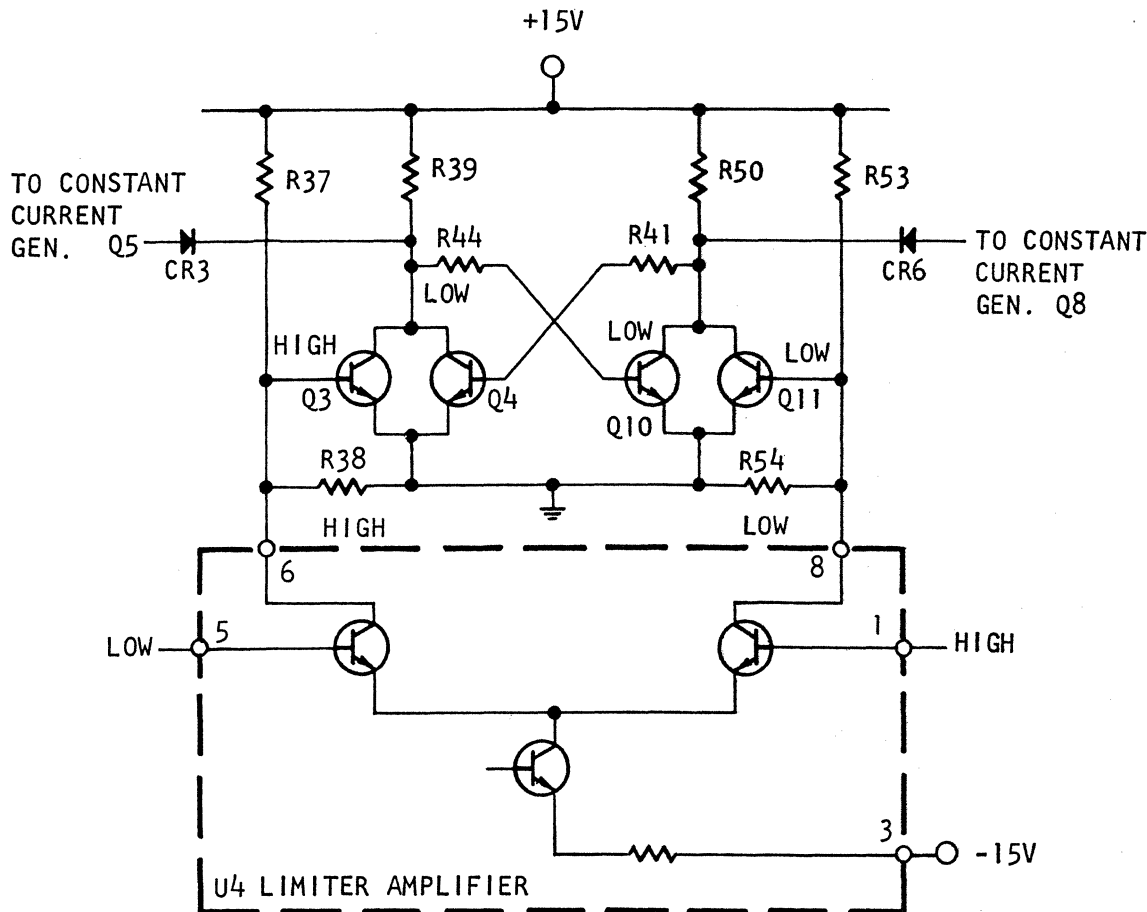


Figure 4-3. Flip-Flop Schematic

4-12. When the output of the limiter U4 at pin 6 is high, pin 8 is low; flip-flop transistor Q3 is turned on and transistor Q11 is turned off. Transistor Q3 grounds the base of Q10 through resistor R44, thereby turning it off. The state at this time is that the Q10-Q11 transistor pair is turned off and the Q3-Q4 pair is turned on. At the next transition of the limiter U4 output waveform, pin 6 goes low and pin 8 goes high; flip-flop transistor Q3 turns off and transistor Q11 is turned on. Transistor Q11 grounds the base of transistor Q4 through resistor R41, thereby turning it off. The new state at this time is that the Q10-Q11 pair is on, and the

Q3-Q4 pair is off. By means of diodes CR3 and CR6, the flip-flop alternately clamps to ground the collectors of transistors Q5 and Q8 in the constant-area pulse generator circuit.

4-13. Constant-Area Pulse Generator. The function of the constant-area pulse generator is to produce constant width current pulses from the reproduced frequency modulated signal. Since the spacing between the pulses varies with modulation, the data is recovered by the integrating action of a low-pass filter.

4-14. Figure 4-4 is a simplified schematic diagram of the pulse generator circuit which may be used to supplement the diagram in Section VII.

4-15. Zener diodes VR2 and VR3, together with diodes CR4, CR5, and CR7, are connected with resistor R55 in series between plus and minus 15 volts to provide temperature compensated reference voltages. Capacitors C28 and C32 maintain the plus and minus 8.1 volt lines, respectively, at a low ac impedance.

4-16. Transistors Q5 and Q8 comprise two current generators. The currents provided by these transistors are constant due to their fixed base-to-emitter potential. The balance control, R42, is adjusted to make the two currents equal by following the procedure in Section V of the system manual.

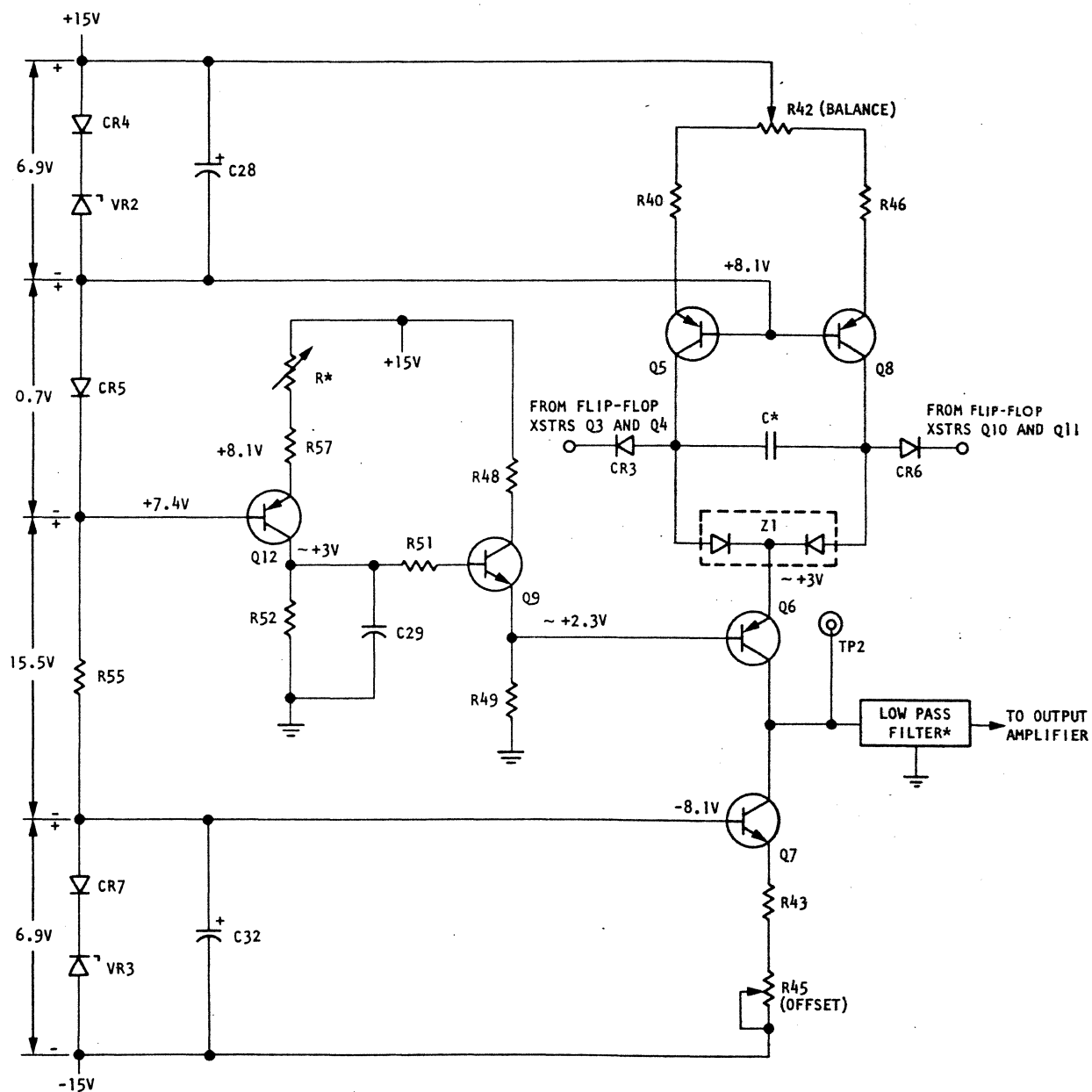
4-17. The flip-flop circuit discussed in paragraphs 4-11 and 4-12 is connected through diodes CR3 and CR6 to the collectors of the current generator transistors Q5 and Q8. One capacitor, C19 to C27, is connected between the two collectors by contacts of relays K2 or K3, which are, in turn, actuated by the speed select lines.

4-18. Figures 4-5, 4-6, and 4-7 show representative waveforms within the frequency discriminator circuitry for zero, negative, and positive carrier deviations, respectively.

4-19. The flip-flop output frequency is the same as the reproduced carrier (including any deviation). The two waveforms have a 50 percent duty cycle and are 180 degrees apart. Each flip-flop output alternately grounds and ungrounds a current generator collector through diode CR3 or CR6.

4-20. When the collector of Q5 is clamped to ground by the flip-flop, current is supplied through the capacitor by Q8. As the capacitor charges, the collector voltage of Q8 increases. During the next half-cycle, transistor Q5 supplies charging current and its collector voltage increases.

4-21. During either half-cycle, the capacitor will charge until one of the diodes in Z1 begins to conduct. At this time, the current from Q5 or Q8 will switch abruptly from the capacitor to a new path through Z1 and transistor Q6. The length of time required for this transition depends upon the capacitor value, the base voltage of transistor Q6, and the current from Q5 or Q8.



*Selected by tape speed logic.

Figure 4-4. Constant-Area Pulse Generator Simplified Schematic

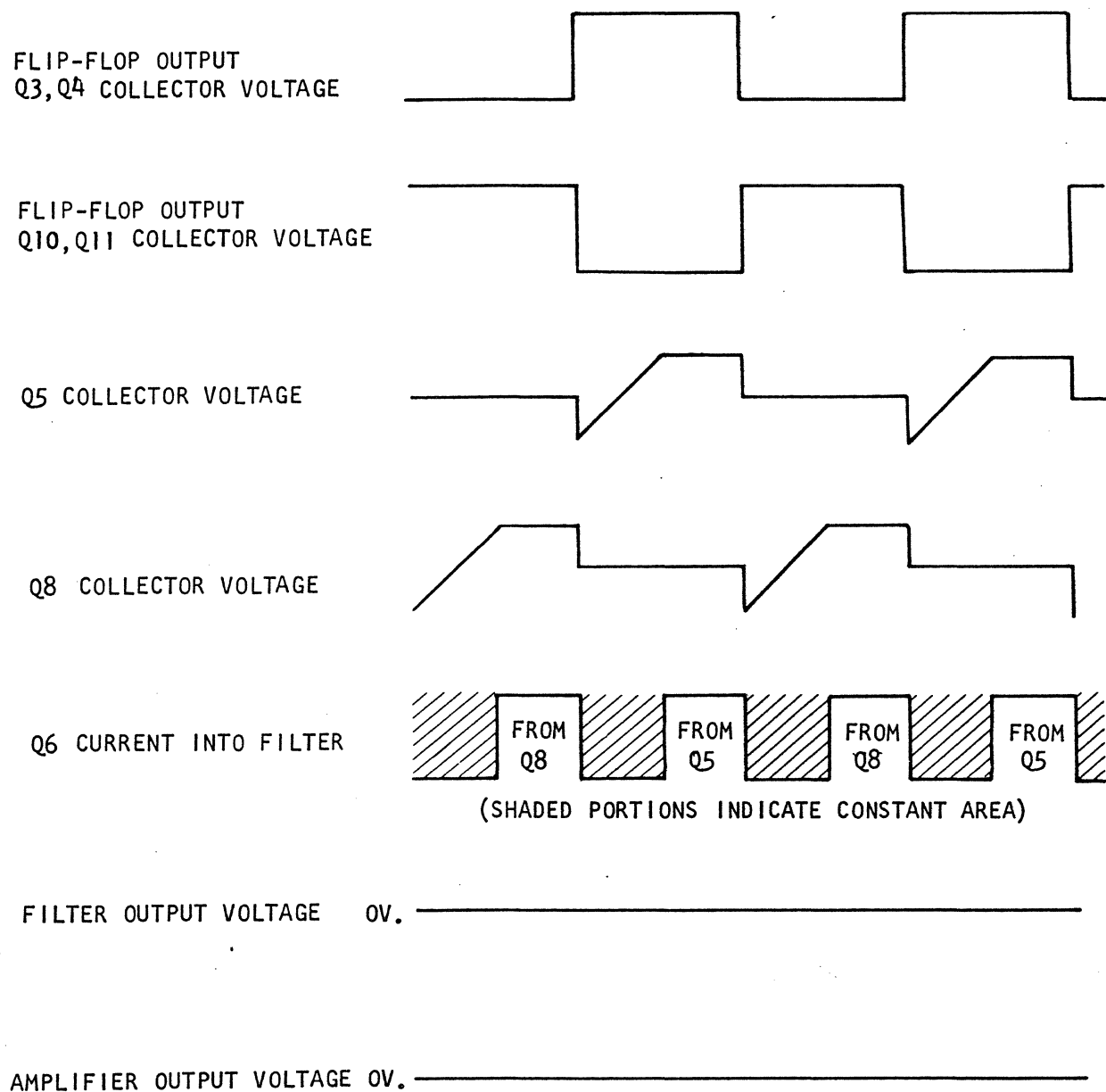


Figure 4-5. Discriminator Waveforms with Zero Carrier Deviation

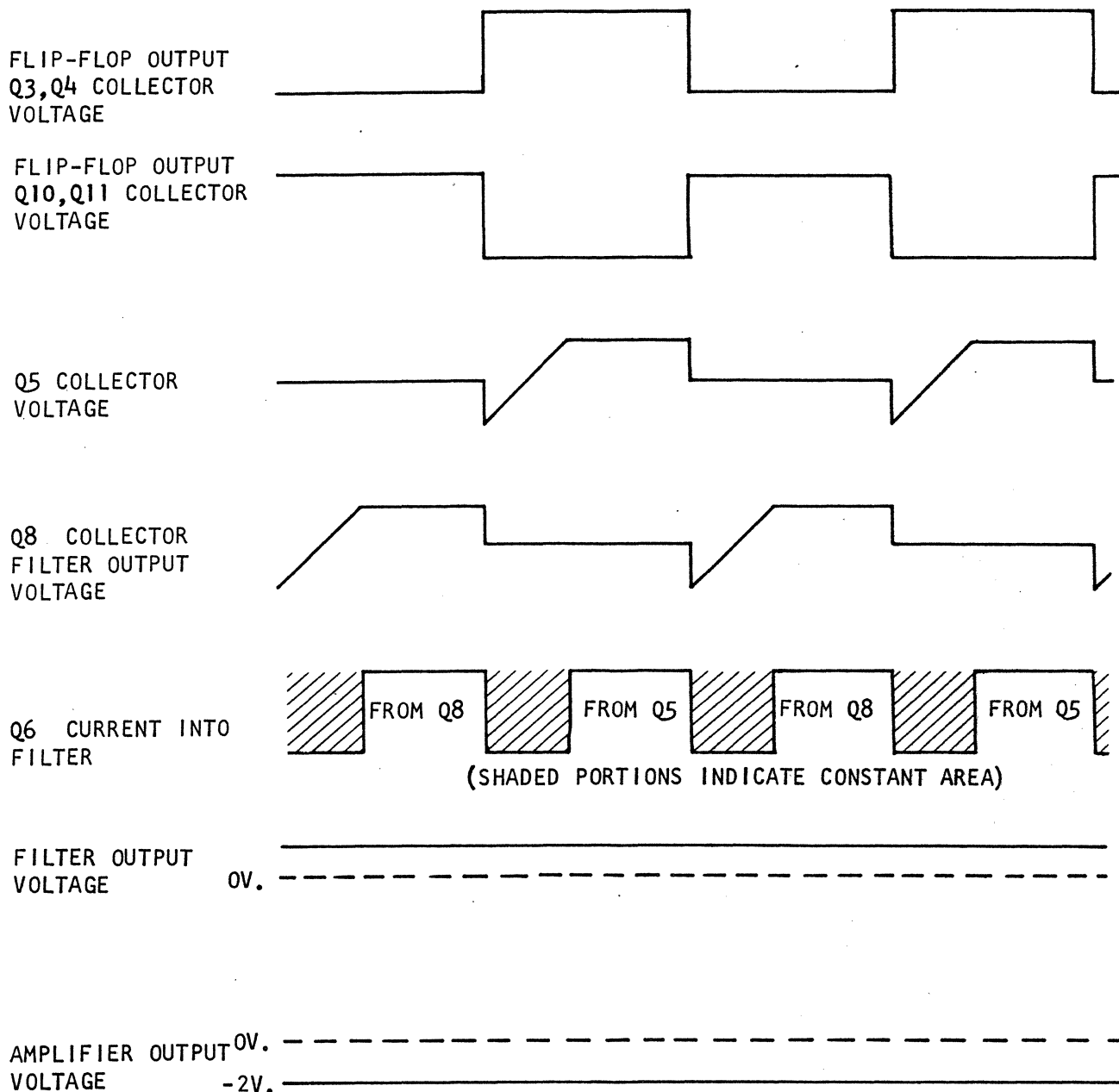


Figure 4-6. Discriminator Waveforms with Negative Carrier Deviation

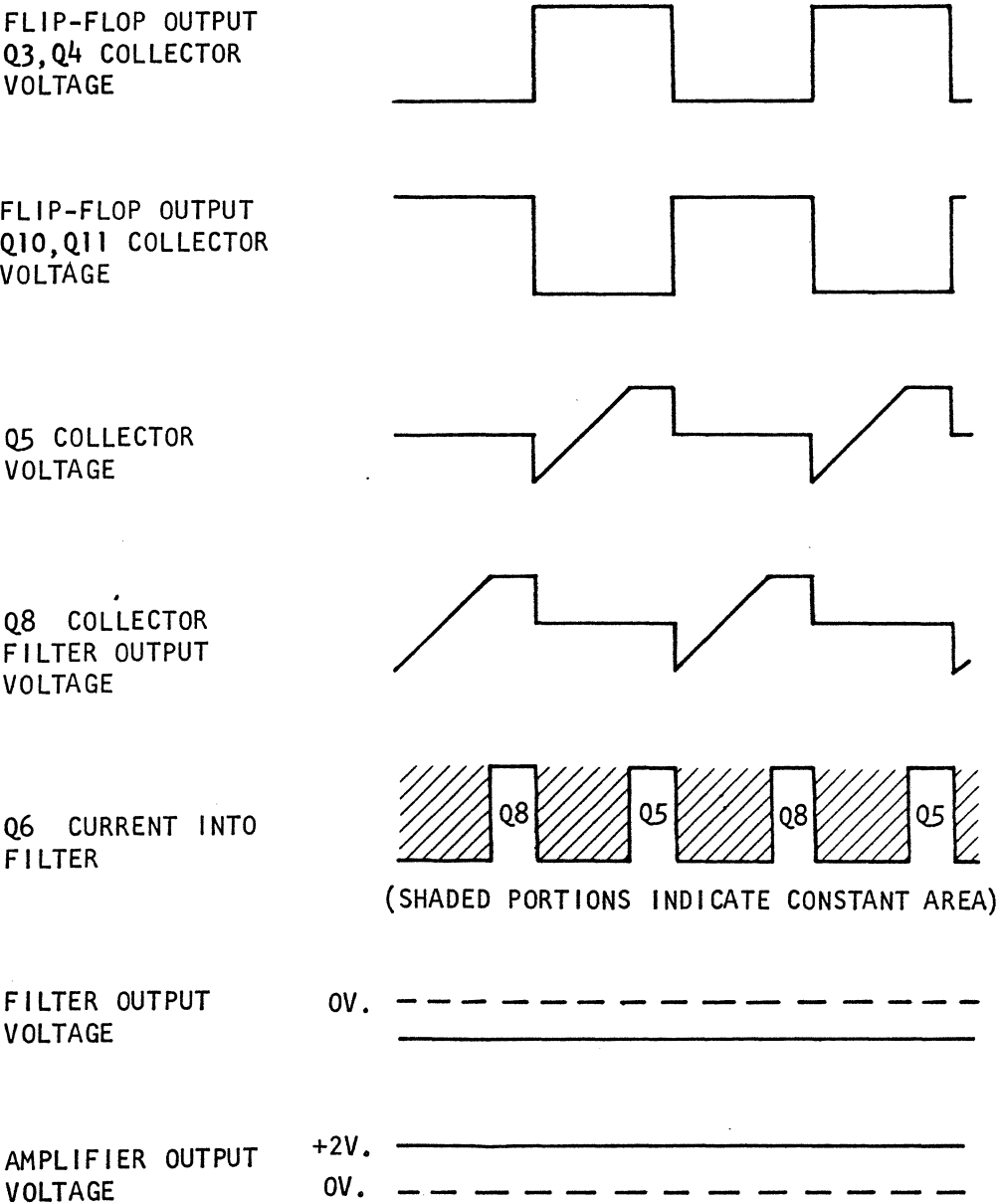


Figure 4-7. Discriminator Waveforms with Positive Carrier Deviation

4-22. The base voltage of transistor Q6 is established by a circuit consisting of transistors Q9, Q12, and associated components. The base voltage of Q12 is fixed at a positive 7.4 volts with respect to ground by the reference voltage divider chain. Transistor Q12 is always biased on, and its collector current is established by the setting of one of the vernier center frequency adjustment potentiometers (R56 or R58) connected in series with resistor R57 between the emitter of Q12 and +15 volts by the speed select logic. The adjustment procedure is described in Section V of the system manual. At mid-position, the adjustment will produce approximately +3 volts at the collector of transistor Q12, which is applied to the base of emitter-follower transistor Q9. This stage will apply approximately +2.3 volts to the base of transistor Q6. This voltage, plus the junction drops of Q6 and Z1, establishes the level at which the current from transistor Q5 or Q8 will switch from the capacitor to a path through Q6. The capacitor must charge to approximately 3.7 volts before the emitter-base junction of Q6 will be forward biased and allow current conduction.

4-23. For any given tape speed, the time when transistor Q6 is not conducting will remain constant, regardless of any carrier deviation. When properly adjusted, this time is equal to one-fourth the period of the unmodulated carrier frequency. Separate timing capacitors and vernier center frequency adjustments for each tape speed maintain this relationship.

4-24. The constant-area pulses corresponding to the absence of transistor Q6 current are shown in the shaded portions of figures 4-5, 4-6, and 4-7. It may be noted by comparing the three figures that the constant-area pulses remain the same size, while the spacing between them varies inversely with the carrier deviation. The constant-area pulses are integrated by one of the low-pass filters FL1 or FL2 which are selected by relay K2 or K3 from the speed select lines. The output voltage from the low-pass filter is proportional to the constant-area pulse spacing.

4-25. An offset circuit consisting of transistor Q7 and associated components is used to provide a bipolar output from the low-pass filter. The base voltage of Q7 is fixed at a negative 8.1 volts with respect to ground, by the reference voltage divider chain. Transistor Q7 is always biased on, and its collector current is established by the setting of offset adjustment potentiometer, R45, which is connected in series with resistor R43 between the emitter of Q7 and -15 volts. When R45 is properly adjusted by following the adjustment procedure in Section V of the system manual, the collector current of transistor Q7 will be exactly half that of transistor Q6. Since Q6 is supplying current to the low-pass filter and Q7 is taking current from it, the filter output voltage is offset so that a negative carrier deviation produces a positive output, zero deviation gives zero output, and positive deviation gives negative output.

4-26. Low-Pass Filters. Low-pass filtering is the final essential block of the complete frequency discriminator. The filter recovers the data by integrating the constant-area, variably spaced pulses from the pulse generator. The resultant average voltage is the same as the data originally recorded, except for polarity and amplitude. (An inverting amplifier follows the filter.)

4-27. A separate, encapsulated filter is used for each tape speed. Each filter has a cutoff frequency equal to the appropriate data bandwidth. This provides optimum signal-to-noise ratio and minimum ripple from the pulse generator. (The pulse generator frequency is twice that of the carrier.)

4-28. Each filter is equipped with a switch to select either flat amplitude or optimum transient response. In the flat amplitude position, the frequency response will be flat within ± 0.5 dB from dc to the cutoff frequency, with less than 14 percent overshoot for a step function input. In the optimum transient position, the frequency response will be flat within ± 0.5 dB and -3 dB, with less than 6 percent overshoot and 1 percent pre-ringing for a step function input.

4-29. OUTPUT AMPLIFIER. The demodulated output signal from the low-pass filter is coupled to the inverting input, pin 2, of the output operational amplifier, U5. The noninverting input, pin 3, is referenced to ground through resistor R62. The output of U5 is taken from pin 6 and is direct coupled to Q15, an emitter-follower. The emitter output of Q15 is connected through resistor R68 to the output BNC connector of the FM reproduce amplifier.

4-30. A negative feedback path is established from the emitter of Q15 through resistor R69, the LEVEL control, and R64 to the inverting input of U5. The output level of the FM reproduce amplifier is controllable by varying the amount of feedback with R69, the LEVEL control.

4-31. Because of the inverting action of the output operational amplifier, the output data signal of the FM reproduce amplifier is of the same polarity as the original data input to the FM record amplifier.

4-32. SQUELCH. The squelch circuit is transport controlled and operates in the STOP, FAST FORWARD, or FAST REVERSE modes, or if the transport is not in phase lock. When in any of the above modes, +5 volts is applied to relay K1 in the FM reproduce amplifier. Normally open contacts, 8 and 14, close and short the input of the low-pass filter to ground, preventing any output from the amplifier.

SECTION V

CALIBRATION AND MAINTENANCE

5-1. GENERAL.

5-2. This section of the 12-457G FM Reproduce Amplifier manual consists of preventive maintenance, and troubleshooting and corrective maintenance. The calibration procedures are contained in Section V of the system manual.

5-3. PREVENTIVE MAINTENANCE.

5-4. Preventive maintenance consists of general cleaning and periodic inspection. Accumulation of dust, dirt, grit, and/or grease on the circuit boards is harmful and should be guarded against by periodic inspection and cleaning. Every six months, under normal laboratory conditions, inspect the units for signs of deterioration, loose connections, insecurity of mounting, and foreign matter. The period of cleaning depends on the particular operational environment and should be determined by inspection. As necessary, clean the circuit board with a soft brush and/or low air pressure, or suitable solvent, being careful not to damage the printed circuitry.

5-5. TROUBLESHOOTING AND CORRECTIVE MAINTENANCE.

5-6. Before attempting repair of a unit suspected of malfunction, verify that the symptom is not caused by malfunction of associated equipment such as the record amplifier, power supply, amplifier case assembly, interconnecting cabling, etc. This can be done by substituting a known good unit for the suspected unit, or by making continuity checks from unit to unit. If such a check eliminates the associated equipment as a source of trouble, check adjustments which are detailed in Section V of the system manual.

5-7. Once the existence of a defective unit has been established, check it for obviously damaged components, such as burned resistors, or incorrect seating of components. The next step is to check that the proper supply voltage is applied to the unit. If the supply voltage is correct, the faulty stage within the unit can be located by tracing signals from stage to stage.

5-8. To trace a signal through the FM record and FM reproduce system, simultaneously record and reproduce while the FM record amplifier input is open-circuited. Check the center frequency at the FM record amplifier and at test point TP1 on the FM reproduce amplifier. Remember that the signal path includes the reproduce head pre-amplifier. The operation and maintenance manuals for these components should be consulted if the signal is lost between the FM record amplifier and connector pin 1 on the FM reproduce amplifier. If the carrier frequency is present at TP1, check for an output from the constant-area pulse generator at TP2. This should be either a triangular or square waveform (depending on the filter response) at a frequency twice that of the carrier. Loss of signal at TP2 could be caused by a defective limiter stage, a defective component in the flip-flop or pulse generator circuit, or an improperly operating squelch circuit. If the system operates normally at

center frequency, connect a dc level to the record amplifier input and check TP1 and TP2 again, together with the filters and output amplifier at the output BNC connector. Refer to Sections IV and VII of this manual for circuit descriptions and schematic diagrams, respectively.

5-9. Once the defective stage has been located, the defective component in that stage can be determined by reference to the schematic diagram, and by making continuity, voltage, and/or resistance measurements about the suspected components. The prime exception to this is open coupling capacitors, which should be checked by substitution, or by adding a known good capacitor in parallel. Transistors Q1, Q2, Q13, and Q14 are switching transistors, the inputs and outputs of which are determined by tape speed selected.

5-10. REPAIR.

5-11. Repair of the unit should be attempted only by personnel experienced in printed wiring techniques. Recommended repair is limited to the replacement of defective parts and adjustment of controls. When removing and replacing defective parts, care should be exercised so as not to damage surrounding components or the circuit board. Replacement parts must be of the correct type and value, as listed in the parts list in Section VI. When installing a new part, place it in the exact position of the replaced part. After replacement, carefully inspect the circuit board for evidence of cold solder joints, solder splashes, and insecurity of mounting. If the equipment is repaired, the amplifiers should be checked and, if necessary, adjusted as described in Section V of the system manual.

5-12. PARTS IDENTIFICATION.

5-13. Components of the 12-457G FM Reproduce Amplifier are illustrated in Section VI of this manual showing locations and part designations. The parts list in Section VI itemizes the component parts in the assembly and provides a Bell & Howell part number for each.

5-14. FIELD REPAIR SERVICE.

5-15. Refer to Section V of the system manual for field repair service information.

5-16. FACTORY REPAIR SERVICE.

5-17. Refer to Section V of the system manual for factory repair service information.

SECTION VI

PARTS LIST

6-1. GENERAL.

6-2. Appropriate parts lists and illustrations for the 12-457G FM Reproduce Amplifier, Bell & Howell part number 534655-0001, covered by this manual follow the instructions given below. The parts list (table 6-1) includes Bell & Howell DATATAPE Division part number, description, figure and index and/or schematic reference symbol, and where applicable, the manufacturer's or military part number for each component.

6-3. MANUFACTURER'S CODES.

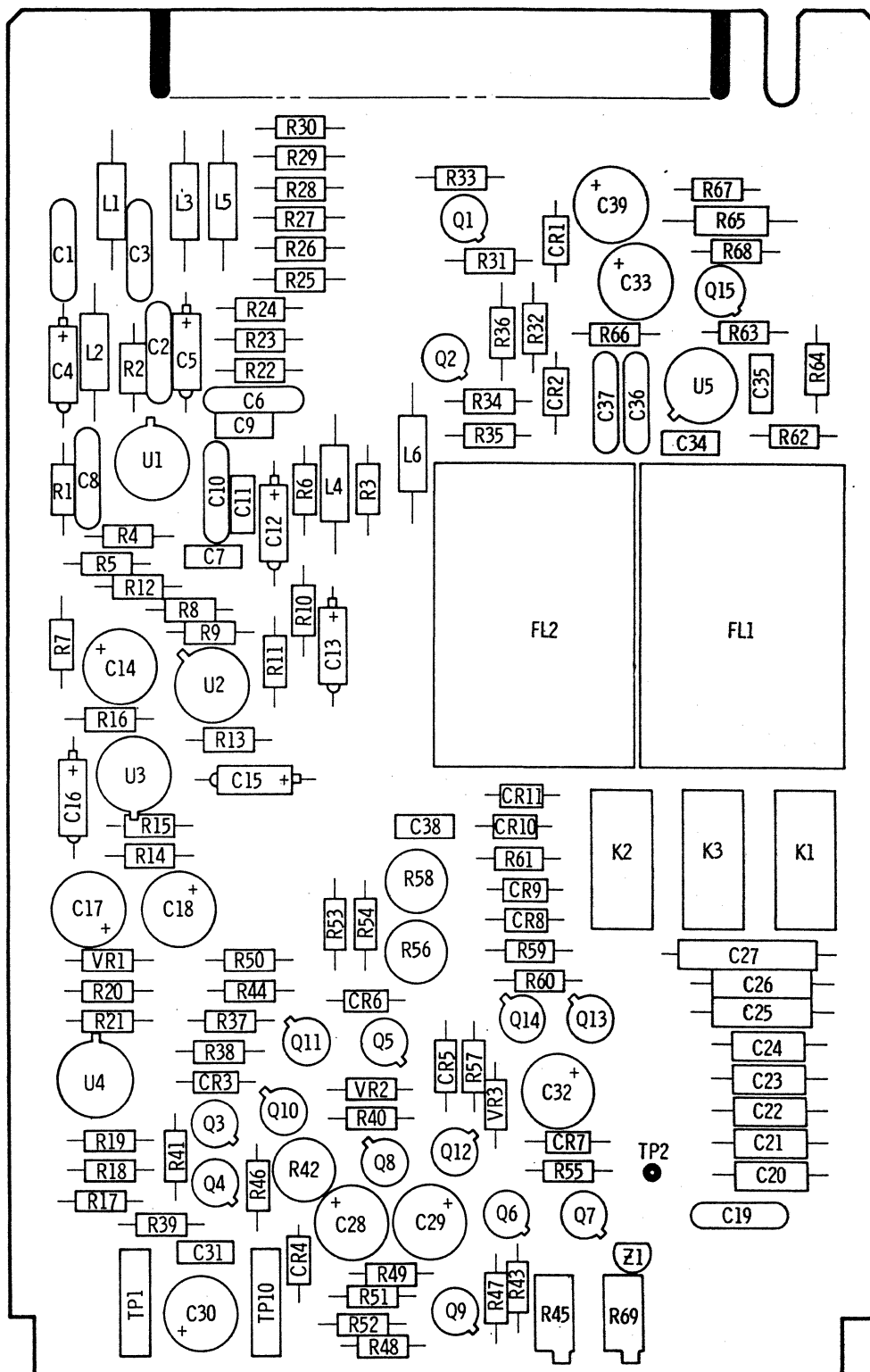
6-4. Manufacturer's code symbols used in the parts list are tabulated in the System manual with the manufacturer's name and address. All code symbols are in accordance with the Federal Supply Code for Manufacturers Handbooks H 4-1 and H 4-2.

6-5. ORDERING REPLACEMENT PARTS.

6-6. When ordering replacement parts refer to Section VI of the System manual for ordering instructions.

6-7. PARTS LOCATION ILLUSTRATIONS.

6-8. Figure 6-1 illustrates the location of components on the circuit card.



D-533247-A (REF)

Table 6-1. Parts List for the 12-457G FM Reproduce Amplifier (Sheet 1 of 6)

ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5 6	QTY	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	534655-0001	FM Reproduce Amplifier Assy	1		14028	
2	533247-0001	Circuit Card Assy, fm reproduce amplifier	1	6-1	14028	
3	70094-0001	Cap, fixed, mica, 1 pF +0.5 pF, 500 Vdc	1	C8	93790	
4	70094-0055	Cap, fixed, mica, 510 pF +5%, 500 Vdc	1	C19	93790	CD19F511J03-500WV
5	173947-1042	Cap, fixed, mica, 10 pF +5%, 500 Vdc	2	C6,36	72136	DM10F100J05004CR
6	173947-1192	Cap, fixed, mica, 51 pF +5%, 500 Vdc	2	C10,37	72136	DM10F510J05004CR
7	378796-0001	Cap, fixed, polycarbonate 2000 pF +5%, 50 Vdc	1	C21	14752	A-1344-0001
8	378796-0002	Cap, fixed, polycarbonate 4000 pF +5%, 50 Vdc	1	C22	14752	A-1344-0002
9	378796-0003	Cap, fixed, polycarbonate 8000 pF +5%, 50 Vdc	1	C23	14752	A-1344-0003
10	378796-0004	Cap, fixed, polycarbonate 15K pF +5%, 50 Vdc	1	C24	14752	A-1344-0004
11	378796-0005	Cap, fixed, polycarbonate 32K pF +5%, 50 Vdc	1	C25	14752	A-1344-0005
12	378796-0006	Cap, fixed, polycarbonate 64K pF +5%, 50 Vdc	1	C26	14752	A-1344-0006
13	378796-0007	Cap, fixed, polycarbonate 128K pF +5%, 50 Vdc	1	C27	14752	A-1344-0007
14	378796-0009	Cap, fixed, polycarbonate 1000 pF +5%, 50 Vdc	1	C20	14752	A-1344-0009
15	471863-0006	Cap, fixed, tantalum 2.2 uF +20%, 25 Vdc	4	C12,13, C15,16	31433	T320A225-M25AS

534655-1-1-TM
D168-A2

Table 6-1. Parts List for the 12-457G FM Reproduce Amplifier (Sheet 2 of 6)

ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5 6	QTY	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	471863-0010	Cap, fixed, tantalum 0.22 uF $\pm 20\%$, 35 Vdc	2	6-1 C4,5	31433	T320A224-M35AS
2	471920-0007	Cap, fixed, tantalum 68 uF $\pm 20\%$, 25 Vdc	9	C14,17, C18,28, C29,30, C32,33, C39	05397	T362-D-686-M- 025-AS
3	479699-0025	Cap, ceramic, 1K pF $\pm 10\%$, 200 Vdc	1	C11	72982	CK05BX102K
4	479699-0049	Cap, ceramic, 0.1 uF $\pm 10\%$, 50 Vdc	6	C7,9,3, C34,35, C38	72982	CK05BX104K
5	7138-1025	Res, fixed, composition 1K ohm $\pm 5\%$, 1/2 W	1	R65		RCR20G102JS
6	366427-0006	Res, var, cermet 500 ohm $\pm 20\%$, 1/2 W	3	R42,56, R58	32997	3339P-1-501
7	521507-0102	Res, var, non wire wound 1K ohm, 1/4 W	2	R45,69		RJ26FX102
8	471922-1012	Res, fixed, metal oxide 100 ohm $\pm 2\%$, 1/4 W	3	R47,51, R63	24546	C4-100 OHM 2 PCT
9	471922-1022	Res, fixed, metal oxide 1K ohm $\pm 2\%$, 1/4 W	5	R7,40,46, R48,64	24546	C4-1K OHM 2 PCT
10	471922-1122	Res, fixed, metal oxide 1.1K ohm $\pm 2\%$, 1/4 W	3	R21,38,54	24546	C4-1.1K OHM 2 PCT
11	471922-1212	Res, fixed, metal oxide 120 ohm $\pm 2\%$, 1/4 W	1	R61	24546	C4-120 OHM 2 PCT
12	471922-1332	Res, fixed metal oxide 13K ohm $\pm 2\%$, 1/4 W	1	R19	24546	C4-13K OHM 2 PCT
13	471922-1532	Res, fixed, metal. oxide 15K ohm $\pm 2\%$, 1/4 W	4	R31,34, R59,60	24546	C4-15K OHM 2 PCT

Table 6-1. Parts List for the 12-457G FM Reproduce Amplifier (Sheet 3 of 6)

ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5 6	QTY	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	471922-1812	Res, fixed, metal oxide 180 ohm $\pm 2\%$, 1/4 W	1	6-1 R28	24546	C4-180 OHM 2 PCT
2	471922-1822	Res, fixed, metal oxide 1.8K ohm $\pm 2\%$, 1/4 W	1	R25	24546	C4-1800 OHM 2 PCT
3	471922-1832	Res, fixed, metal oxide 18K ohm $\pm 2\%$, 1/4 W	1	R22	24546	C4-18K OHM 2 PCT
4	471922-2012	Res, fixed, metal oxide 200 ohm $\pm 2\%$, 1/4 W	1	R66	24546	C4-200 OHM 2 PCT
5	471922-2022	Res, fixed, metal oxide 2K ohm $\pm 2\%$, 1/4 W	8	R9,11,14, R15,17, R18,43,57	24546	C4-2K OHM 2 PCT
6	471922-2032	Res, fixed, metal oxide 20K ohm $\pm 2\%$, 1/4 W	2	R1,2	24546	C4-20K OHM 2 PCT
7	471922-2202	Res, fixed, metal oxide 22 ohm $\pm 2\%$, 1/4 W	1	R68	24546	C4-22 OHM 2 PCT
8	471922-2232	Res, fixed, metal oxide 22K ohm $\pm 2\%$, 1/4 W	1	R6	24546	C4-22K OHM 2 PCT
9	471922-3012	Res, fixed, metal oxide 300 ohm $\pm 2\%$, 1/4 W	1	R67	24546	C4-300 OHM 2 PCT
10	471922-3022	Res, fixed, metal oxide 3K ohm $\pm 2\%$, 1/4 W	3	R39,50,55	24546	C4-3000 OHM 2 PCT
11	471922-3312	Res, fixed, metal oxide 330 ohm $\pm 2\%$, 1/4 W	1	R62	24546	C4-330 OHM 2 PCT
12	471922-3612	Res, fixed metal oxide 360 ohm $\pm 2\%$, 1/4 W	1	R27	24546	C4-360 OHM 2 PCT
13	471922-3622	Res, fixed, metal. oxide 3.6K ohm $\pm 2\%$, 1/4 W	1	R24	24546	C4-3600 OHM 2 PCT
14	471922-3922	Res, fixed, metal oxide 3.9K ohm $\pm 2\%$, 1/4 W	2	R13,16	24546	C4-3900 OHM 2 PCT

Table 6-1. Parts List for the 12-457G FM Reproduce Amplifier (Sheet 4 of 6)

ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5 6	QTY	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	471922-3932	Res, fixed, metal oxide 39K ohm $\pm 2\%$, 1/4 W	3	6-1 R3,4,5	24546	C4-39K OHM 2 PCT
2	471922-4302	Res, fixed, metal oxide 43 ohm $\pm 2\%$, 1/4 W	1	R30	24546	C4-43 OHM 2 PCT
3	471922-5102	Res, fixed, metal oxide 51 ohm $\pm 2\%$, 1/4 W	2	R12,20	24546	C4-51 OHM 2 PCT
4	471922-5112	Res, fixed, metal oxide 510 ohm $\pm 2\%$, 1/4 W	1	R10	24546	C4-510 OHM 2 PCT
5	471922-5122	Res, fixed, metal oxide 5.1K ohm $\pm 2\%$, 1/4 W	2	R32,35	24546	C4-5.1K OHM 2 PCT
6	471922-5622	Res, fixed, metal oxide 5.6K ohm $\pm 2\%$, 1/4 W	4	R37,41, R44,53	24546	C4-5600 OHM 2 PCT
7	471922-6212	Res, fixed, metal oxide 620 ohm $\pm 2\%$, 1/4 W	1	R49	24546	C4-620 OHM 2 PCT
8	377373-0002	Lead, electrical, 2.13 length straight term	4		14028	
9	471922-6802	Res, fixed, metal oxide 68 ohm $\pm 2\%$, 1/4 W	1	R8	24546	C4-68 OHM 2 PCT
10	471922-6822	Res, fixed, metal oxide 6.8K ohm $\pm 2\%$, 1/4 W	2	R33,36	24546	C4-6.8K OHM 2 PCT
11	471922-7522	Res, fixed, metal oxide 7.5K ohm $\pm 2\%$, 1/4 W	1	R23	24546	C4-7.5K OHM 2 PCT
12	471922-8212	Res, fixed metal oxide 820 ohm $\pm 2\%$, 1/4 W	2	R26,52	24546	C4-820 OHM 2 PCT
13	471922-9102	Res, fixed, metal oxide 91 ohm $\pm 2\%$, 1/4 W	1	R29	24546	C4-91 OHM 2 PCT
14	205933-0001	Diode, zener, 1N821 6.2 V $\pm 5\%$	2	VR2,3	04713	1N821

Table 6-1. Parts List for the 12-457G FM Reproduce Amplifier (Sheet 5 of 6)

ITEM NO.	B&H PART NO.	DESCRIPTION	QTY	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
		0 1 2 3 4 5 6				
1	246008-0311	Semiconductor Device, diode 8.2 V	1	6-1 VR1	04713	1N959B
2	246954	Diode Signal Switching 24 V Work Volt 1N4154	5	CR1,2,4, CR7,8,9	03508	1N4154
3	371982-0001	Diode	1	CR5		
4	372295-0002	Diode, rectifier 1.0A, 200 V, 1N4003	2	CR10,11	04713	1N4003
5	378772	Diode, dual	1	Z1	04713	MSD6100
6	521520-0112	Diode, 1N4376	2	CR3,6	14028	JAN1N4376
7	472015	Filter, low pass type 13-560	2	FL1,2	23880	
8	471472	Transistor, NPN 2N3947	7	Q1,2,7, Q9,13, Q14,15	04713	2N3947
9	532438	Transistor, NPN, silicon type 2N2369A	4	Q3,4,10, Q11	04713	2N2369A
10	471931	Transistor, PNP 2N3251	4	Q5,6,8, Q12	04713	2N3251
11	472466-0023	Inductor, fixed, shielded 120 uH $\pm 5\%$	2	L5,6	76493	9250-124-5PCT
12	472466-0042	Inductor, fixed, shielded 680 uH $\pm 5\%$	1	L4	72259	SWD-680-5PCT
13	471788-0005	Inductor, fixed 22 uH $\pm 10\%$	3	L1,2,3	99800	1537-44
14	378773	Integrated Circuit	3	U2,3,4	86684	CA3028A
15	520980	Integrated Circuit	2	U1,5	34371	HA2-2625-5
16	472460-0501	Relay, reed type 1 form A	1	K1	15636	RA30381051

Table 6-1. Parts List for the 12-457G FM Reproduce Amplifier (Sheet 6 of 6)

ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5 6	QTY	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	472460-1202	Relay, reed type 2 form A	2	6-1 K2,3	15636	RA30382121
2	204749-1003	Jack, tip, horizontal, pc black	1	TP10	83330	430-103
3	204749-1008	Jack, tip, horizontal, pc brown	1	TP1	83330	430-108
4	376087-0002	Connector, (vertical jack) red	1	TP2	74970	105-852
5	173947-1222	Cap, fixed, mica 68 pF $\pm 5\%$, 500 Vdc	3	C1,2,3	72136	DM10F680J05004CR
6	362914-0324	Cable, special purpose, electrical, 3 cond, 24 AWG white/black/red	1		12814	EXE-24-1936- (3)STJ
7	539387	Plate, electrical shield	1		14028	
8	379494-0002	Panel, front, amplifier module	1		14028	
9	479639	Plate, connector mount	1		14028	
10	007127-0002	Terminal, lug, solder screw, size 3/8	1		71002	4
11	126732-0031	Connector, coaxial panel receptacle	1	J1	91836	KC-79-46
12	126716-0178	Cable, rf, coaxial RG-178B/U	1		23172	QPL-17

SECTION VII
DRAWINGS AND SCHEMATICS

7-1. GENERAL.

7-2. This section contains the schematic drawing, figure 7-1, for the 12-457G FM Reproduce Amplifier. All connections shown are part of the amplifier mother board assembly which is covered in the Tape Transport manual.

EXTENDED WIDE BAND GROUP I									
FILTER NO. 1					FILTER NO. 2				
SIGNAL FREQ (kHz)	TAPE SPEED (ips)		CENTER FREQ	GAIN	SIGNAL FREQ (kHz)	TAPE SPEED (ips)		CENTER FREQ	GAIN
80	60	E24-E33	E1-E3	E21-E14	40	30	E23-E34	E2-E4	E22-E15
40	30	E24-E34	E1-E4	E21-E15	20	15	E23-E35	E2-E5	E22-E16
20	15	E24-E35	E1-E5	E21-E16	10	7-1/2	E23-E36	E2-E6	E22-E17
10	7-1/2	E24-E36	E1-E6	E21-E17	5	3-3/4	E23-E37	E2-E7	E22-E18
5	3-3/4	E24-E37	E1-E7	E21-E18	2.5	1-7/8	E23-E38	E2-E8	E22-E19
2.5	1-7/8	E24-E38	E1-E8	E21-E19	1.25	15/16	E23-E39	E2-E9	E22-E20
1.25	15/16	E24-E39	E1-E9	E21-E20					

FOR EXTENDED WIDE BAND GROUP I USE ONLY THE HI SPEED POSITION OF THE HI/LO SPEED SWITCH.

WIDE BAND GROUP I									
FILTER NO. 1					FILTER NO. 2				
SIGNAL FREQ (kHz)	TAPE SPEED (ips)		CENTER FREQ	GAIN	SIGNAL FREQ (kHz)	TAPE SPEED (ips)		CENTER FREQ	GAIN
40	60	E24-E33	E1-E4	E21-E13	20	30	E23-E34	E2-E5	E22-E14
20	30	E24-E34	E1-E5	E21-E14	10	15	E23-E35	E2-E6	E22-E15
10	15	E24-E35	E1-E6	E21-E15	5	7-1/2	E23-E36	E2-E7	E22-E16
5	7-1/2	E24-E36	E1-E7	E21-E16	2.5	3-3/4	E23-E37	E2-E8	E22-E17
2.5	3-3/4	E24-E37	E1-E8	E21-E17	1.25	1-7/8	E23-E38	E2-E9	E22-E18
1.25	1-7/8	E24-E38	E1-E9	E21-E18	0.625	15/16	E23-E39	E2-E10	E22-E19
0.625	15/16	E24-E39	E1-E10	E21-E19	0.312	15/32	E23-E39	E2-E11	E22-E20

FOR 15/16 SPEED IN FILTER NO. 1 POSITION USE 1/2 SPEED POSITION OF HI/LO SPEED SWITCH. FOR 15/32 SPEED USE 1/2 SPEED SWITCH POSITION.

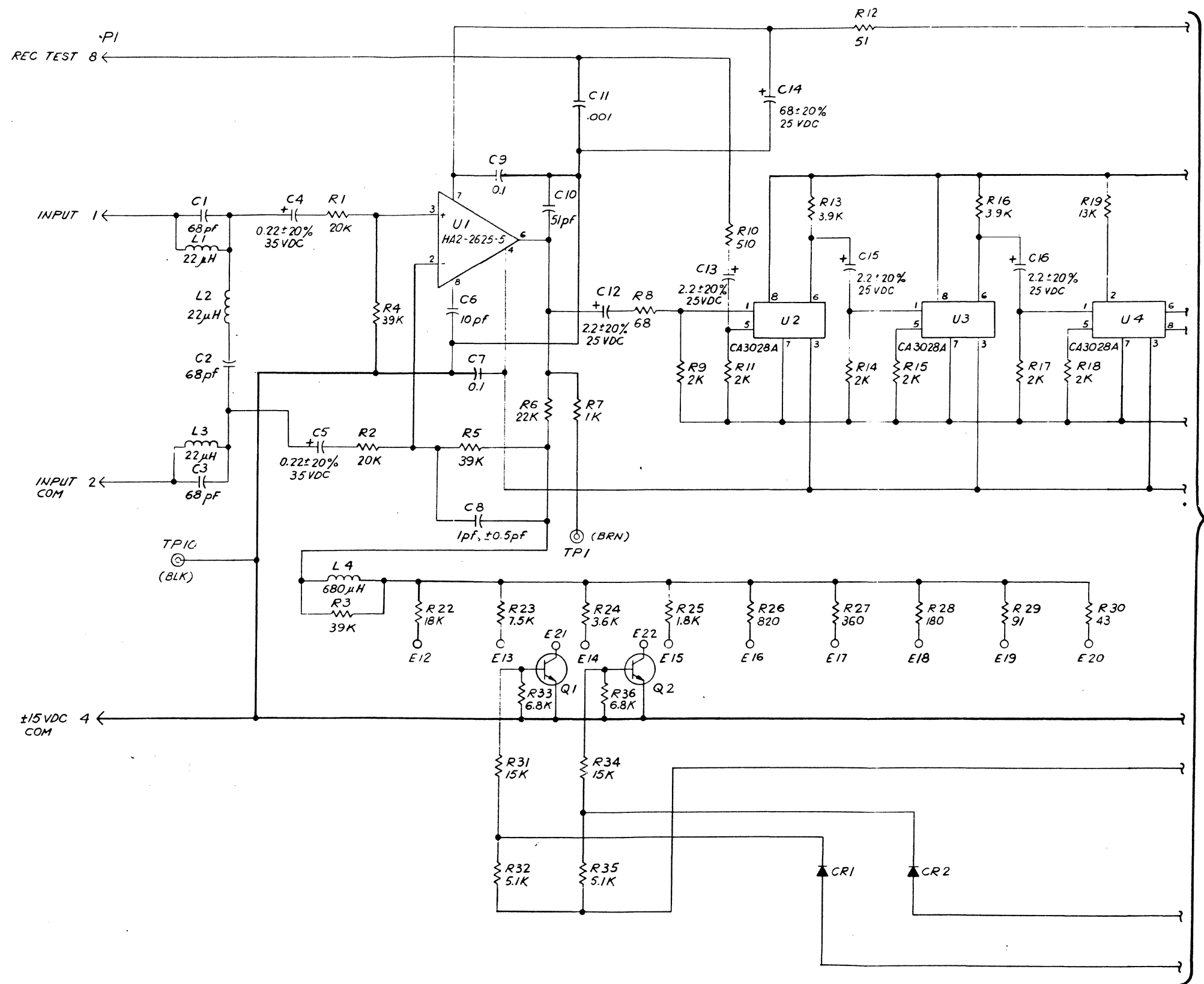
INTERMEDIATE BAND									
FILTER NO. 1					FILTER NO. 2				
SIGNAL FREQ (kHz)	TAPE SPEED (ips)		CENTER FREQ	GAIN	SIGNAL FREQ (kHz)	TAPE SPEED (ips)		CENTER FREQ	GAIN
20	60	E24-E33	E1-E5	E21-E12	10	30	E23-E34	E2-E6	E22-E13
10	30	E24-E34	E1-E6	E21-E13	5	15	E23-E35	E2-E7	E22-E14
5	15	E24-E35	E1-E7	E21-E14	2.5	7-1/2	E23-E36	E2-E8	E22-E15
2.5	7-1/2	E24-E36	E1-E8	E21-E15	1.25	3-3/4	E23-E36	E2-E9	E22-E16
1.25	3-3/4	E24-E37	E1-E9	E21-E16	0.625	1-7/8	E23-E36	E2-E10	E22-E17
0.625	1-7/8	E24-E38	E1-E10	E21-E17	0.312	15/16	E23-E37	E2-E11	E22-E18
0.312	15/16	E23-E39	E1-E11	E21-E18					

FOR INTERMEDIATE BAND USE ONLY THE HI SPEED POSITION OF THE HI/LO SPEED SWITCH.

60 IPS	17	←	○	E33
30	16	←	○	E34
15	15	←	○	E35
7 1/2	14	←	○	E36
3 3/4	13	←	○	E37
1 7/8	12	←	○	E38
15/16 IPS	11	←	○	E39

LAST COMPONENT DESIGNATION USED:
C39, CR11, E44, K3, L6, Q15, R69, TP10, U5, VR3, Z1, FL2
COMPONENT DESIGNATION NOT USED
TP3 THRU TP9

- ① FL1 & FL2 ARE LOW PASS SELECTABLE FILTERS.
6. ALL TRANSISTOR ARE 2N3947.
5. ALL DIODES ARE IN4154.
4. CAPACITORS < 620pF ARE MICA, $\pm 5\%$, 500 VDC.
3. ALL CAPACITORS ARE IN MICROFARADS $\pm 5\%$, 50 VDC.
2. ALL VARIABLE RESISTORS ARE IN OHMS $\pm 20\%$, 1/2 W.
1. ALL FIXED RESISTORS ARE IN OHMS $\pm 2\%$, 1/4 W.
- NOTES: UNLESS OTHERWISE SPECIFIED

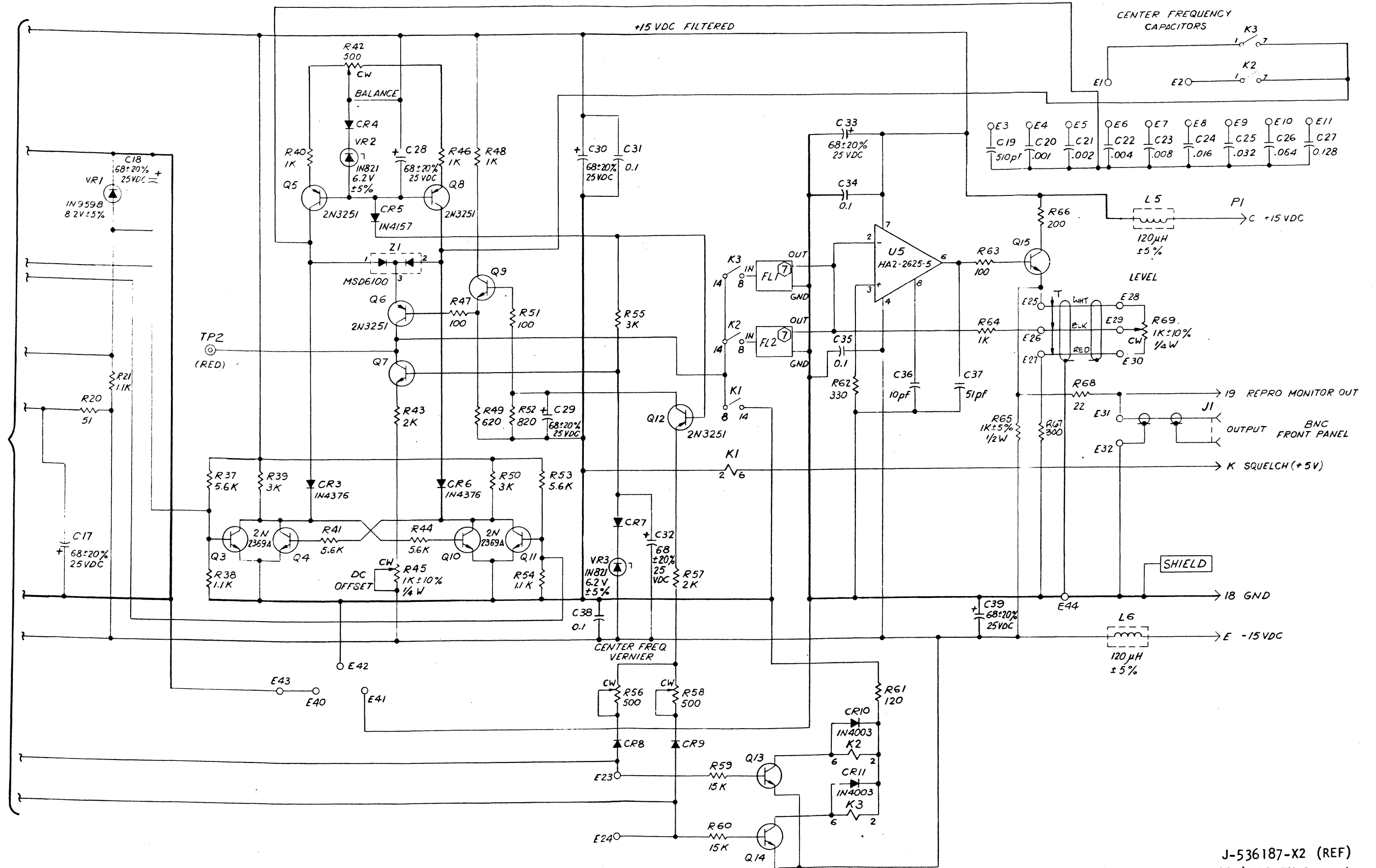


TO
SHEET
2 OF 2

J-536187-X2 (REF)

Figure 7-1. Schematic, 12-457G FM Reproduce Amplifier (Sheet 1 of 2)
7-3/(7-4 blank)

FROM
SHEET
1 OF 2



J-536187-X2 (REF)
Figure 7-1. Schematic, 12-457G FM Reproduce Amplifier (Sheet 2 of 2)
7-5/(7-6 blank)